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A NEW INDUSTRY—MANUFACTURE OF SOUND-ABSORBING MATERIALS

In the bureau's files there is to be found the record of the development of a new industry. This of itself is noteworthy, but additional interest attaches to this case from the fact that fully three-quarters of this development has occurred during the business depression of the last three years. Reference is made to the manufacture of sound-absorbing materials for use in correcting the acoustic quality of auditoriums.

Though the underlying principles of architectural acoustics have been known for nearly 40 years, the subject attracted but little attention from those who should have been interested until the introduction of talking pictures. It was then found that many theaters which had been built for silent pictures were acoustically almost useless. This discovery stimulated the study of means for correcting the difficulty and directed attention to such sound-absorbing materials as were then available.

These materials were limited in number, and some of them were serious fire risks. Development of new materials to meet the demand brought requests for service in the measurement of their sound absorption.

In 1928 the facilities for this work were limited to two laboratories, both in the State of Illinois. In the fall of 1928 the Bureau of Standards completed a reverberation room for making such tests and placed it in service. During the remainder of that year its facilities were used by two manufacturers.

In 1929 seven different firms sent material for measurement, and this number was increased to 18 in 1930 and 23 in 1931, in which year the total number of samples measured was 97. For the first half of 1932 the demand for service of this character has been considerably in excess of the 1931 rate.

Another measure of the extent to which the bureau has been connected with this new manufacturing development is found in the increasing correspondence on the subject. So frequent became letters of inquiry regarding different acoustic materials that early in 1930 it became necessary to issue a "letter circular" on the subject. The first edition of this circular in March, 1930, listed 11 materials which the bureau had measured up to that time. Seven editions of this "letter circular" have been called for, each edition listing an increasing number of materials. The latest edition, of April, 1932, lists 37 different

materials, with several varieties of each, totaling 87.

In addition to furnishing this service, the bureau has been called upon by architects for advice regarding the preliminary calculation of the acoustic quality of a proposed auditorium. It has become an established rule of the Government architects to submit to the bureau all plans for new Federal court rooms throughout the country for suggestion and criticism in this respect.

The bureau has also done its share toward developing improved methods and instruments for making sound-absorption measurements. The following publications, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices named, give a description of the bureau's work along these lines.

Heyl, Paul R., Architectural acoustics, B. S. Circular No. 396, 1931. (C396, 5¢.)

Eckhardt, E. A., and Chrisler, V. L., Transmission and absorption of sound by some building materials, B. S. Sci. Papers, vol. 21, p. 37, 1926-27. (S526, 15¢.)

Heyl, Paul R., Chrisler, V. L., and Snyder, W. F., The Absorption of sound at oblique angles of incidence, B. S. Jour. Research, vol. 4, p. 289, 1930. (RP149, 5¢.)

Chrisler, V. L., and Snyder, W. F., The measurement of sound absorption, B. S. Jour. Research, vol. 5, p. 957, 1930. (RP242, 10¢.)

INFLUENCE OF ATMOSPHERIC CONDITIONS ON SOUND ABSORPTION

During the past two years a study has been made at the bureau of the sound-absorbing properties of air under various conditions. As a result of this study some curious facts have been found. When the air is very dry sound is absorbed much more readily than when the air is full of moisture. Also when the temperature is high, sound is absorbed better than when it is cold. This increased absorption is most pronounced for sounds of high pitch. The conditions then for maximum absorption are those prevailing on a hot, dry day. Under these conditions it has been found that sound can not be heard as far as on a cool, damp day.

This problem is of considerable interest in broadcasting studios where an attempt is made to keep the absorption constant. This can be done by

the use of an air conditioning system, and in many studios such a control has been installed.

It has also been found that the rate of decay of sound in a room does not follow exactly the uniform law that has hitherto been assumed, but that the rate of decay is influenced by the area of absorbing material present and its distribution.

Research Paper No. 465, in the August number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH, will give a complete account of this work.

VACUUM TUBE AMPLIFIER FOR FEEBLE PULSES

In recent years various experimenters have attempted to amplify and record the primary ionization produced when a single corpuscular ray, such as a high-speed electron or alpha ray, passes through a shallow ionization chamber. Wynn-Williams and Ward working in England and Le-prince-Ringuet in France have described successful amplifiers of this kind. These amplifiers, however, use foreign tubes, and the details of their circuits are of little value to those who must use radio tubes made in this country. In Research Paper No. 461, which will appear in the August number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH, a description is given of an amplifier using the commercial a. c. screen grid amplifier tubes and a pentode, combined with a special electrometer tube which can be made in any laboratory having facilities for glass blowing. This amplifier, when used with an improved ionization chamber which is described, will give current pulses of the order of 50 milliamperes for a single alpha particle. This means that the original current produced when the alpha particle passes through the ionization chamber has been amplified to approximately a thousand million times its original value. This arrangement is of great assistance in studying atomic disintegration and is essentially the same as that used by Doctor Chadwick, of Cambridge, England, in the recently reported discovery of the "neutron."

INFRA-RED SPECTRA OF HELIUM

When helium is inclosed at reduced pressure in a glass tube and excited to luminosity by the passage of an electric discharge it emits a yellowish light which is characteristic of helium atoms or molecules. On dispersion into a spectrum, numerous bright lines

are observed, and the interpretation of these lines has its basis in the structure of the element.

Up to the present time there was a large gap in the spectrum just beyond the visible limit in the red in which no helium lines were known. This gap has now been explored at the bureau with photographic plates sensitized to infra-red radiations by means of xeno-cyanine, a new dye discovered by the Eastman Kodak Research Laboratories, and 120 new spectral lines have been found. Practically all of the new lines have been accounted for; 32 of them result from energy changes in neutral helium atoms and the remainder are due to vibration and rotation energy changes in helium molecules, each consisting of two joined helium atoms. A more detailed description of this discovery will appear as Research Paper No. 462 in the August number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

LEGIBILITY OF BAROGRAPH TRACES

Tests were recently completed at the bureau to determine the legibility of barograph traces made upon charts sprayed with a lampblack solution when differently shaped scribes were used. Tests were also made to determine the best kind of paper to use for the chart. It was found that a trace made by a sharp or pin-pointed scribe was superior to those made by the other two types of scribes in common use, namely, the fairly blunt point obtained by shaping the end of the barograph arm and the triangular cup type which is used necessarily when the traces are made in ink upon white paper. The pin-pointed scribe is commonly made by soldering a straight pin to the end of the arm of the barograph, bending it in a suitable manner and sharpening it upon a stone. Three types of paper were tested—a thin typewriting paper, bond letterhead paper, and a heavy paper commonly called "statement paper." The statement paper was the most satisfactory, as it was the easiest to handle and gave the best trace.

LATHE ATTACHMENT FOR TURNING APPROXIMATELY SPHERICAL SURFACES

When constructing machinery or tools it is often necessary to produce a small portion of a spherical surface of which the radius of curvature is large. For example, in the production of optical surfaces on lenses, grinding tools are often from 5 to 20 inches in

diameter and faced by surfaces of which the radii of curvature may be as great as 10 or 20 feet. For more moderate values of the radius of curvature such surfaces are easily produced on a lathe by a tool carried on the end of a radius rod, but for the larger values this method is inconvenient or impracticable. There is a method by which such surfaces can be milled, but this requires a special machine of heavy and very expensive construction which is not ordinarily available. In a method more commonly used the surface is produced on a lathe by a single-tooth tool guided by a carefully constructed template. With this method a separate template is necessary for each required radius, and the method, therefore, is satisfactory only when a large number of surfaces having the same radius of curvature is desired.

A new attachment has now been constructed at the bureau for producing these curved surfaces. It is relatively inexpensive and is substituted for the compound slide rest on a lathe. A special linkage guides the tool in such a manner as to generate an approximately spherical surface. By a simple adjustment the linkage can be set to produce either a convex or a concave surface with any desired radius of curvature greater than a certain minimum value which is approximately 20 inches for the attachment which has been constructed. The approximation to a spherical surface becomes better as either the curvature or diameter of the surface is decreased. A surface of 8 inches in diameter with a radius of curvature of 40 inches is produced with a departure from a spherical surface which is less than 0.001 inch. If the radius of curvature is decreased to 20 inches and the diameter of the surface is 12 inches, the departure is approximately 0.01 inch. This last value is the maximum value for any surface lying within the working range of the instrument.

This development will be described in detail in Research Paper No. 467 in the August number of the BUREAU OF STANDARDS JOURNAL OF RESEARCH.

SPECIFICATIONS FOR PHOTOGRAPHIC PAPER

Specifications for photographic black-line paper and photographic negative paper, prepared by the photographic supplies committee of the Federal Specifications Board, have been approved for use of the departments and

independent establishments of the Government in the purchase of those commodities. The service requirements for the papers are rather severe, because they must be strong to withstand frequent handling and have sufficient purity to last for many years without appreciable deterioration. The specifications are of special interest because the fiber requirements are based on information developed in the bureau's studies on the permanence of paper. The results obtained in these studies have indicated that ability of a paper to resist aging is dependent, as far as the character of the fibers is concerned, on their cellulosic purity. Consistent with this new criterion of quality, the specifications contain no reference to the kind of fiber stock, except a requirement in each case that it be free from unbleached or highly lignified fibers, such as ground wood fibers, which are known to be harmful.

The detail requirements include values for wet tensile strength sufficient to withstand handling when wet by immersion in developing solutions and such values for alpha cellulose content and copper number as to insure sufficient purity of the cellulosic materials composing the papers. The alpha cellulose test is a measure of the unmodified cellulose present, and the copper number test is a measure of the degraded cellulose or harmful substances. Permanent paper is characterized by high alpha cellulose content and low copper number.

Cooperative tests for one manufacturer indicated that the black-line and negative papers regularly furnished by him failed to meet the chemical purity requirements of the specifications. A paper stock of foreign manufacture was used in these papers, and it is of interest to note that this manufacturer by substituting a domestic paper stock has improved his products to such an extent that they now conform to the specifications in all respects.

INFLUENCE OF TEMPERATURE ON EVOLUTION OF HYDROGEN SULPHIDE FROM VULCANIZED RUBBER

When raw rubber is heated with sulphur it undergoes a marked change in properties and forms what is commonly known as vulcanized rubber. The amount of sulphur combined with the rubber may range from a fraction of 1 per cent to about 32 per cent. The products containing the lower percentages of sulphur are soft and occur

in familiar articles, such as automobile tires and many household rubber goods. The ordinary hard rubber is an example of a compound containing the higher percentages of sulphur.

Vulcanized rubber is used commercially in many articles, such as gaskets, steam hose, and brake lining, which are subjected to relatively high temperatures. When vulcanized rubber is heated, it gives rise to an unpleasant odor which becomes more intense and more disagreeable the higher the temperature. The odor is due in large part to sulphur compounds which are derived from the sulphur that was used to vulcanize the rubber. This loss of sulphur is accompanied, in general, by deterioration in the electrical and mechanical properties of the rubber.

A study has been made at the bureau to ascertain the extent to which rubber of various compositions decomposes on heating. The purpose of the investigation was to determine to what temperature and for what length of time vulcanized rubber could be heated without producing a serious change in the composition. In this study measurements were made of the principal product of decomposition—hydrogen sulphide. Below the temperature of boiling water the rate of decomposition was so slow that no significant portion of the sulphur content was lost. As the temperature was increased, however, the rate of evolution of hydrogen sulphide increased rapidly. Hard rubber, vulcanized with about one-third its weight of sulphur, lost hydrogen sulphide much more rapidly than did soft rubber vulcanized with only a fraction as much sulphur. After 24 hours' heating at 430° F., hard rubber lost about one-third of its sulphur content and changed to a brittle, translucent, reddish-brown material.

The results of this investigation afford fundamental data from which it is possible to determine how much a sample of rubber will decompose when the composition of the rubber and the time and temperature are given.

Measurements were not made on the change in strength, or other physical properties, although qualitative observations in this regard were recorded. For a complete account of the work, Research Paper No. 464, which will be published in the BUREAU OF STANDARDS JOURNAL OF RESEARCH for August, should be consulted.

ADHESIVENESS OF BITUMINOUS PIPE COATINGS

A paper entitled "Adhesive Characteristics of Pipe-Coating Bitumens," by H. S. Christopher, of the Bureau of Standards, prepared for publication in *Western Gas*, outlines some of the basic facts which govern the adhesion of bituminous coating materials to pipe surfaces.

Bitumens can be bonded either through heating the pipe or by first coating the metal with a primer. Of the two methods, by far the best bond is secured by heating the metal surface, since this removes air and moisture from the interfacial area and prevents chilling of the hot secondary bitumen. The advantage of such procedure is that it makes primers unnecessary and actually increases the bond strength to a point beyond the cohesive strength of the bitumen. Unfortunately, the procedure is not feasible in field operations, which therefore require primers. Because drying times, consistencies, and adhesive characteristics vary within wide limits laboratory check ups are required.

Tests of adhesiveness can be made with apparatus of a type with which the bureau has been experimenting. This involves the application of slowly incremented force which pulls a steel plate away from contact with bitumen. The apparatus is actuated by the Smith ductility machine.

Bitumens exhibit adhesiveness values varying from as low as 28 to more than 200 lbs./in.²

According to the manner in which the bitumen separates from the metal (cleanly or otherwise) four distinct conditions are recognized which are arbitrarily designated as A, B, C, and D. These empirical values may be used in rating bitumens as to adhesive qualities, and otherwise judging their value for pipe-coating purposes.

CURBSTONE PAINT

In connection with some work for the District of Columbia, there was applied on July 24, 1931, a single coat of four paints, A, B, C, and D, on a section of a concrete curbstone (unpainted) facing the chemistry building of the bureau. Paints A and B were red paints of about the same color, and paints C and D were yellow paints of about the same color. The purpose of the practical outdoor exposure test was to compare paint A with paint B (the two red paints), and paint C with paint D (the two yellow paints).

These four paints were of the following composition:

Paint A had a pigment of 100 per cent toluidine toner and a vehicle of 100 per cent spar varnish, in the proportion of 8 per cent pigment and 92 per cent varnish. This paint or enamel conformed to Federal specification TT-E-531.

Paint B had a pigment of 12 per cent paranitraniline red, 15 per cent magnesium silicate, and 73 per cent barium sulphate, and a vehicle of 85 per cent linseed oil and 15 per cent thinner and drier, in the proportion of 50 per cent pigment and 50 per cent vehicle. Just before using, 1 pint of spar varnish corresponding to Federal specification TT-V-121 was added to each gallon of paint.

Paint C had a pigment of 40 per cent C. P. chrome yellow, 10 per cent zinc oxide, and 50 per cent barytes, and a vehicle of 85 per cent linseed oil, 10 per cent mineral spirits, and 5 per cent drier, in the proportion 60 per cent pigment and 40 per cent vehicle.

Paint D was the same as Paint C except that just before using, 1 pint of spar varnish corresponding to Federal specification TT-V-121 was added to each gallon of paint.

After one year of exposure an inspection was made on July 25, 1932, with the following results:

Paint A.—Film is sound and the original color is almost perfect.

Paint B.—Film is sound, but the original color has completely changed from a bright red to a faded-out, pinkish purple; very unsightly.

Paint C.—Film is sound, with only slight change (darkening) of color.

Paint D.—Film is sound and the color retention is somewhat better than in paint C.

It therefore appears that an excellent bright red curbstone paint or enamel may be procured under Federal specification TT-E-531 (paint A). A good, bright yellow curbstone paint may be obtained from a paint similar to paint D. These two paints would not dry quickly enough for road or traffic paints.

PROPORTIONING CONCRETE

Although thousands of tests have been made to determine the laws for proportioning concrete in order to secure the highest strength at the least cost, there are so many possible combinations of the ingredients that the formulation of a simple rule to cover all cases has defied the most expert. No two sands are exactly alike in fineness, and there are wide variations

in texture and strength of the particles. The same may be said regarding the gravel or other coarse aggregates. Different cements also behave differently. Although most cements now on the market are satisfactory as judged by the Government specifications, some barely pass and others give strengths considerably in excess of the requirements. Besides this, an excess in the amount of water used in the mix over that necessary to give sufficient plasticity to the concrete to permit it to be worked into the corners of the forms and around the reinforcement seriously reduces the strength.

The bureau has made tests, the results of which form the basis of a paper to be published in the Proceedings of the American Society of Civil Engineers, in which an effort has been made to formulate rules which will simplify the procedure in many cases. Although this investigation included tests with 232 combinations with different cements, different proportions of fine aggregate (sand) to coarse aggregate, and different sizes of coarse aggregate, these 232 combinations represent only a small proportion of the possible combinations. The tests which were made indicate that for some cases there should be as much fine aggregate as coarse aggregate, while for other cases the volume of the fine may be as little as one-half that of the coarse aggregate, but that for the majority of cases the volume of fine should be about two-thirds that of the coarse aggregate. The tests also indicated that the combination of aggregates which gives the mix most easily worked into the forms is likely to require the least cement to give the strength necessary.

MEASUREMENT OF MOISTURE EXPANSION OF CLAY PRODUCTS

A number of items have been issued in the Technical News BULLETIN (Nos. 146, 153, 156, 160, and 161, June, 1929, and January, April, August, and September, 1930, respectively) on the subject of length changes of porous clay products resulting from contact with moisture. These changes in length, which take place slowly in ordinary humid atmospheres, but which may be accelerated greatly by subjection to water under pressure at elevated temperatures, have been termed moisture expansion. They have been measured either directly by means of a comparator, or indirectly by heating the specimen and observing with an interferometer the contraction accompany-

ing the expulsion of the water assumed to be proportional to the expansion which took place when the water was taken up by the specimen. The indirect method is to be desired when conditions of testing preclude the use of long specimens. Heretofore no information has been available regarding how closely the "indirect" values approximate the "direct." The following moisture-expansion values were obtained by autoclaving earthenware rods (12 cm long and 1 1/4 cm in diameter) for five hours in water vapor at 183° C. under a pressure of 150 lbs./in.², measuring the length change directly over a 10 cm span, and cutting appropriate specimens from the rods for determination of the length changes by the indirect method.

Specimen	Direct method	Indirect method
	Per cent	Per cent
C-3	0	0.01
C-4	0	0
B-3	.23	.23
B-4	.22	.21
D-5	.11	.10

THERMAL EXPANSION OF FIRE CLAY AND FIRE-CLAY BRICK

Two samples of fire clay and two of fire-clay brick are included in the bureau's investigation of the linear thermal expansion of refractories to 1,800° C. The clays were tested after heating at (1) 1,155° C. for two hours; (2) 1,400° C. for five hours, and (3) either 1,575° or 1,660° C., depending on the temperature to which samples (1) and (2) were taken in the initial test. The brick were tested as received from the manufacturer and also after heating above 1,600° C. The maximum expansion, 0.77 per cent of the highly siliceous clay (70 per cent SiO₂) heated at 1,155° C., was obtained at 900° C.; when heated at 1,400° C. this value was 0.75 per cent and was obtained at 1,000° C.; when heated at 1,575° C. the maximum expansion, 1.74 per cent, was reached at 1,420° C. A Pennsylvania clay (45 percent SiO₂) after the 1,155° C. heat treatment, reached its maximum expansion, 0.50 per cent, at 1,100° C.; after heating at 1,400° C. this value was 0.70 per cent and was obtained at 1,250° C.; after heating to 1,660° C. the maximum expansion, 0.74 per cent, was obtained at 1,430° C.

A Missouri flint fire-clay brick, tested as received, had a maximum expansion of 0.62 per cent which was

noted at 1,120° C. After this same specimen had been heated to 1,615° C., this value became 0.80 per cent and was obtained at 1,275° C.

A Missouri semiflint fire-clay brick showed its greatest expansion, 0.66 per cent, at 1,130° C. when tested as received. After reheating the same sample to 1,660° C. this value became 0.63 per cent and was noted at 1,400° C.

Rapid contraction occurred in all the specimens after the temperature at which maximum expansion was reached, and accelerated with increase of temperature. Both the highly siliceous clay (1,575° C. reheat) and the semiflint fire-clay brick (as received) showed a very high rate of expansion between 1,430° and 1,520° C., indicating the possibility of the high temperature form of cristobalite.

THERMAL EXPANSIVITY OF TYPICAL GROUND COAT ENAMELS

Thermal expansivity has been studied on the same group of typical vitreous enamel ground coats concerning which previous items relating to other properties have appeared. (See TECHNICAL NEWS BULLETIN No. 173, September, 1931.) Both the interferometer and a dial indicating apparatus, that involves the use of fused quartz tubes for transmitting expansion movements of the specimen to the dial, were used in making these determinations.

The determined mean coefficients from room temperature to 100° C. are in reasonably good agreement with the values calculated from the Mayer and Havas factors, which are based upon experiments made in that temperature range. The substitution of sodium oxide for boric oxide and of feldspar for flint, however, caused noticeably smaller increases in the determined values than in the calculated values. From the observed data mean coefficients of expansion were computed also over the respective intervals from room temperature to 200°, 300°, 400° C. and softening temperature as indicated by the interferometer. All of these values were higher than the calculated coefficients, and they increased with the temperature until at 400° C. they were on the average nearly 20 per cent higher. The mean coefficients from room temperature to the softening temperatures of the respective enamels were nearly twice the calculated values, due to the sudden increase in rate of expansion above 400° C.

CELLULAR SHEET-STEEL FLOORING

The weights of floors in buildings are often greater than the loads which they support. Consequently engineers are interested in methods of reducing this dead load, since any such reduction would permit economies in the frames and foundations.

There has recently been completed at the bureau a study of the behavior under transverse loading of a new lightweight cellular floor made from sheet steel. The floor consists of two corrugated sheets spot-welded together into a panel 2 feet wide and of lengths up to 12 feet. The weights of the specimens tested ranged from 8 to 16 lbs./ft.². These panels have the additional advantage that electrical and plumbing lines can be placed in the ducts formed by the longitudinal cells.

In the tests, which will be reported in Research Paper No. 463 in the August number of the Bureau of Standards Journal of Research, the panels were loaded at the quarterpoints and the deflections and strains measured at midspan. It was found that the methods customarily used by engineers when designing steel structures were satisfactory for predicting the elastic behavior of the floor panels. These panels will carry uniformly distributed loads of from 200 to 940 lbs./ft.² on a 10-foot span before they begin to depart from elastic behavior. The concentrated reactions at the ends of the panels and the concentrated loads at the quarterpoints did not greatly affect the strength or other properties of the panels. The maximum load carried by the specimens was, in all cases, considerably higher than the elastic limits of the panels. This fact and the relatively great deflection under maximum load provides an ample margin of safety against sudden failure under excessive loads or under impact.

In the course of the investigation the tensile properties of the sheet steel and the shearing strength of the spot welds were also determined. A new type of specimen was devised for making tests of the welds.

REVISED METRIC PAMPHLET

All those interested in the metric system of weights and measures will welcome the revised (third) edition of "The International Metric System of Weights and Measures," which has just been released.

This pamphlet gives a brief history of the system, including the establish-

ment of the International Bureau of Weights and Measures at Paris by 17 nations, including the United States. This is followed by a revised list of the various countries which now support this bureau. A complete synopsis of the system follows, with explanations of the methods of deriving the various units.

Quotations are given from the laws of the United States, defining the status of the metric system in this country.

Lastly, tables are included giving a comparison of the metric and customary units of weight and measure.

Several changes have been made in the pamphlet since the second edition which was published in 1922. These include a revision of the list of nations supporting the International Bureau of Weights and Measures, certain changes in the text which make for greater clearness, revision in legends accompanying illustrations, discarding of obsolete material and insertion of new data, and certain revisions in the table of equivalents.

Copies of this publication (Bureau of Standards Miscellaneous Publication No. 135) may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

NEW AND REVISED PUBLICATIONS ISSUED DURING JULY, 1932

Journal of Research¹

Bureau of Standards Journal of Research, vol. 9, No. 1, July, 1932 (RP Nos. 453 to 460, inclusive). Price, 25 cents. Obtainable by subscription.

Research Papers¹

(Reprints from Journal of Research)
RP419. Fluctuations of the rate of emission of alpha particles for weak sources and large solid angles; L. F. Curtiss. Price, 5 cents.

RP421. Experiments on the emission and absorption of radiation by metallic silver; F. L. Mohler. Price, 5 cents.

RP424. Air density corrections for X-ray ionization chambers; L. S. Taylor and G. Singer. Price, 5 cents.

RP433. The spectral erythemic reaction of the untanned human skin to ultra-violet radiation; W. W. Coblenz, R. Stair, and J. M. Hogue. Price, 5 cents.

RP435. Graphical determination of polar pattern of directional antenna systems; G. L. Davies and W. H. Orton. Price, 5 cents.

RP437. Simplified automatic Wilson chamber; L. F. Curtiss. Price, 5 cents.

RP438. Isolation of normal decane from petroleum by distillation and equilibrium melting; J. H. Bruun and M. M. Hicks-Bruun. Price, 5 cents.

RP439. A laboratory apparatus for the continuous extraction of liquids by low-boiling solvents; R. T. Leslie. Price, 5 cents.

RP440. Volume changes of cast irons during casting; E. J. Ash and C. M. Saeger, Jr. Price, 5 cents.

RP441. A study of the delta lactones formed by the oxidation of aldoses with bromine water; H. S. Isbell. Price, 5 cents.

RP443. Investigation of the method of determining the relation of statical hysteresis and flexural stresses by measurement of the decrement of a freely vibrating U bar; G. H. Keulegan. Price, 5 cents.

RP444. An unrecognized property of the reversible pendulum; P. R. Heyl. Price, 5 cents.

RP445. A method for the determination of cobalt in magnet and high-speed tool steels; J. I. Hoffman. Price, 5 cents.

Simplified Practice Recommendations¹

R127-31. Folding boxes (used by department and specialty stores). Price, 5 cents.

R128-31. Corrugated boxes (used by department and specialty stores). Price, 5 cents.

Commercial Standards¹

CS1-32. Clinical thermometers (supersedes CS1-28). Price, 5 cents.

CS38-32. Hospital rubber sheeting. Price, 5 cents.

Miscellaneous Publications¹

M135. The international metric system of weights and measures (revision of M2). Price, 5 cents.

Commercial Standards Monthly¹

Commercial Standards Monthly, vol. 9, No. 1, July, 1932. Price, 10 cents. Obtainable by subscription.

Technical News Bulletin¹

Technical News Bulletin No. 183, July, 1932. Price, 5 cents. Obtainable by subscription.

¹ Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year (United States and its possessions, Canada, Cuba, Mexico, Newfoundland, and Republic of Panama); other countries, 70 cents. Subscription to Journal of Research, \$2.50 per year; other countries, \$3.25. Subscription to Commercial Standards Monthly, \$1; other countries, \$1.60.

LETTER CIRCULARS²

LC333. Outside house painting.
 LC334. Spray painting.
 LC335. Uses of transmissions of standard radio-frequencies. (Replaces LC314.)
 LC336. Luminous paints.
 LC337. Painting water tanks.

OUTSIDE PUBLICATIONS³

Judson, L. V., Progress report on investigation of invar tapes and precision circles, *Transactions, American Geophysical Union* (National Research Council, Washington, D. C.), thirteenth annual meeting, p. 79, 1932.
 Davis, R., and Neeland, G. K., Experimentelle untersuchung verschiedener methoden die photographische empfindlichkeit darzustellen, Sonderdruck aus bericht über den VIII Internat. Kongresz für Photographie, Dresden, 1931.
 Carroll, Burt H., Automatic apparatus for intermittent washing, *Industrial and Engineering Chemistry, Analytical Edition* (Washington, D. C.), vol. 4, p. 323, July 15, 1932.
 Waters, C. E., American contemporaries—Percy Hargraves Walker, *Industrial and Engineering Chemistry* (Washington, D. C.), vol. 24, p. 834, July, 1932.
 Bailey, H. W., Device for removing "frozen" plugs from stopcocks, *Industrial and Engineering Chemistry, Analytical Edition* (Washington, D. C.), vol. 4, p. 324, July 15, 1932.
 Hughes, E. E., and Appel, W. D., The effect of dry cleaning solvents upon

² "Letter circulars" are in mimeographed form and are designed primarily to answer specific inquiries. The supply is necessarily limited so that, in general, but one copy can be sent in answer to each request. Copies are available only on application to the Bureau of Standards, Washington, D. C. No mailing list is maintained for letter circulars, and complete sets of back numbers can not be furnished.

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Briggs, Lyman J., "George Kimball Burgess," *Science* (New York, N. Y.), vol. 76, p. 46; July 15, 1932.
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